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20. (Amended) A thermal transfer roller, comprising:

a first end chamber in communication with a source of fluid;

an annulus in communication with the first end chamber; and

a plurality of channels in the first end chamber, each channel having a wider end closer to the annulus, and a narrower end, wherein a distance between the wider end of each channel and the wider ends of adjacent channels is about the same as a distance between the narrower end of each channel and the narrower ends of adjacent channels.

REMARKS

Applicants' undersigned attorney thanks the Examiner for his comments. The present invention is directed to a fluid distribution apparatus that employs novel flow control channels to substantially overcome angular and spiral fluid motion in the end disk chambers while simultaneously providing a substantially even fluid supply and distribution to the annulus. Prior art fluid distribution apparatuses use radially disposed channels at the ends of thermal transfer rollers. However, these channels are increasingly spaced apart as they approach the outer surface of the roller. While the prior art channels have mostly uniform diameters, the walls between them become progressively thicker toward the outer surface of the

roller. Due to the increased spaces between the radial channels at their respective outer ends, the heat transfer fluid is not evenly distributed as it enters the annulus.

Construction of large diameter fluid heat transfer rolls are advantageously made with disk shaped chambers on each end, which are used to move the fluid into and out of the annulus formed between the inner and outer shells. Rotation of the rolls causes the fluid in the end chambers to move in a spiral fashion relative to the internal structure of the roll. This spiral motion causes losses in overall fluid flow to the annulus, and losses in heat transfer. In order to reduce flow losses with the resultant loss in heat transfer coefficient, it is desirable that the fluid flow radially out (relative to the rotating roll) to the annulus and pass through the holes in the inner shell while flowing in-line with the hole centerlines. It is also desirable that the fluid approach the annulus with uniform fluid distribution.

The present invention satisfies these objectives by restraining the flow with radial baffles defining progressively wider channels therebetween, as shown in Fig. 1. Without the baffles, the conservation of angular momentum of the fluid would cause it to lag behind the rotation of the roll as friction forces on the disk chamber sidewalls increase its angular momentum but are not able to fully impart the required energy. The result would be a tangential component of velocity as the fluid approaches the annulus. For example, if the roll is rotating clockwise from the viewer's perspective standing outside the roll, the fluid inside the chamber would

rotate counter-clockwise relative to the roll internals. This would cause friction losses due to the increase in fluid velocity, and the consequent need to pass fluid through openings entering the annulus at an angle, instead of a substantially radial direction.

Similarly, in the opposite disk chamber where the fluid is removed, it moves radially downward from the annulus to the center supply tube. In order to reduce flow losses with the resultant loss in heat transfer coefficient, it is required that the fluid flow radially straight in (relative to the rotating roll) to the exit tube without developing a vortex. The present invention causes that to happen by the same mechanism described above, and shown in Fig. 1. Without the baffles, the conservation of angular momentum of the fluid would cause it to rotate faster than the rotation of the roll as friction forces on the disk chamber sidewalls reduce its angular momentum but are not able to fully remove it. The result would be a tangential component of velocity as the fluid approaches the roll center, generating a strong vortex flow pattern.

The present invention includes a heat transfer roller with a roll journal on one or both ends provided with a passage for injecting and/or removing heat transfer fluid to and from the roller. A disk-shaped chamber is provided on one or both ends of a heat transfer roll for carrying heat transfer fluid between the corresponding roller journal and the annulus. The disk-shaped chamber or chambers are provided with a plurality of novel flow control channels which pass between the

corresponding journal and the annulus. As shown in Fig. 1, and recited in amended Claims 1 and 14, the channels become progressively wider between the narrower end and near the roll center, and the wider end near the annulus. This progression of channel width substantially reduces the angular flow of fluid while maintaining a uniform distance between adjacent channels (i.e., a uniform wall thickness) as recited in amended Claim 20.

The flow control channels of the present invention have a progressively larger width approaching the annulus, and a progressively narrower width approaching the journal. The channels may be defined by substantially radially-projecting walls extending between the journal and the annulus. The radially-projecting walls may be provided by inserting an assembly of radial-projecting baffles into an open disk-shaped chamber on the roller end. As shown in Fig. 1, the walls may have substantially uniform thickness, facilitating a uniform distance between adjacent channels.

As explained on page 5 of the specification, these channels which are progressively wider toward the annulus and progressively narrower toward the journal substantially reduce and minimize the spacing between adjacent channels at the annulus. This feature permits the flow control apparatus to substantially reduce the angular and spiral flow of fluid within the end chamber or chambers, and to provide a substantially uniform and even distribution of fluid flow to the annulus.

Amendments to the Specification

The specification has been amended at Page 10, lines 10, 16 and 17 to correct the element numerals assigned to the first (inlet) end and the second (outlet) end. The element numeral 20 was inadvertently used to identify both the first (inlet) end and the spiral walls, therefore Applicants have re-assigned the first (inlet) end as element numeral 21. Similarly, the element numeral 24 was used to identify the journal, and the second (outlet) end was also inadvertently referred to as element 24 in line 10. The proper element numeral representing the second (outlet) end is 22, as correctly represented in Fig. 2. Line 16 has been further amended to correctly describe the flow of the fluid as indicated by the arrows in Fig. 2.

Amendments to the Claims

Independent Claims 1 and 14 have been amended to indicate that each channel becomes progressively wider between the first (narrower) end and the second (wider) end. Independent Claim 20 has been amended to require that the distance between the wider end of each channel and the wider ends of adjacent channels is about the same as the distance between the narrower end of each channel and the narrower ends of adjacent channels. Support for this amendment is found in the specification on page 12, lines 14-16, wherein it is taught that the walls separating adjacent channels do not increase in thickness between their inner ends near the

journal and their outer ends near the annulus. Further support is found in Applicants' Fig. 1.

Claim Rejections - 35 USC §102

The rejection of Claims 1-3, 8, 14, 18 and 20-25 under 35 USC §102(b) as being anticipated by Richards (U.S. Patent 3,135,319) is respectfully traversed. Richards discloses a leveling roll wherein discrete radial passages are used to transfer coolant from one end of the leveling roll, through corresponding discrete longitudinal passages, to an opposite end of the leveling roll (Col. 3, line 73 - Col. 4, line 13). As shown in Fig. 2 of Richards, in view of Figs. 1 and 3, the radial passages 26 and 27 are in close proximity to one another near the journal shaft and are more spaced from one another near the outer roll member. Also, the channels have a mostly uniform diameter but become suddenly wider near their outer ends. Due to the sudden widening of the channels near their outer ends, the angular fluid flow is not minimized, but instead would <u>suddenly increase</u> near the outer roll member. Due to the increase in space between adjacent channels and the sudden angular motion of the fluid, the heat transfer fluid is less evenly distributed to the annulus. Applicants recognize this problem, as indicated on pages 2 and 3 of their specification, and respond to the problem with the present invention.

More particularly, the present invention includes a disk-shaped chamber with a plurality of flow control channels, rather than discrete radial passages, wherein

the flow control channels progressively increase in width from one end to another end such that the channels have a wider end approaching the annulus, and a narrower end approaching the journal. As explained on page 5 of the present specification, these closely spaced, width-varying channels substantially reduce the angular and spiral flow of fluid within the disk-shaped chamber while providing a substantially uniform and even distribution of fluid flow to the annulus. The progressively varying channel width is accomplished via substantial uniformity in wall thickness between the channels, which necessarily leads to uniformity in distance between adjacent channels.

Richards teaches away from a disk-shaped chamber housing closely spaced, progressive width-varying channels. Richards teaches two separate groups of radial passages, each radial passage of each group communicating with a passage that extends longitudinally within the body of the leveling roll between the ends thereof. Fig. 2 and the specification at Col. 3, line 73 - Col. 4, line 13 suggest that each radial passage has a uniform width along most of its length, and is spaced at a larger distance from each adjacent radial passage at the outer end of the passage, than at the inner end. The mostly uniform widths of the radial passages and the increased distances between the passages at their respective outer ends, contradict the teachings in the present invention. Also, the <u>sudden</u> widening of channels at their outer ends

does not accomplish the objective of the invention, namely, the minimization of angular flow and the maintenance of uniform fluid distribution.

Applicants urge that the above Amendment and remarks overcome the rejection of Claims 1-3, 8, 14, 18 and 20-25 as being anticipated by the Richards patent.

Claim Rejections - 35 USC §103

The rejection of dependent Claims 4, 9 and 19 under 35 USC §103 as being unpatentable over the cited Richards patent in view of Smith, Jr. (U.S. Patent 3,228,462) is respectfully traversed.

Claim 4 depends from amended Claim 1, which Applicants believe is patentable for the reasons presented above. Likewise, Claim 9 depends from Claim 2 which depends from amended Claim 1. Claim 19 depends from amended Claim 14, which Applicants believe is patentable for the reasons presented above.

The Richards patent and/or the Smith, Jr. patent, alone or in combination, do not teach or suggest the claimed disk-shaped chamber with channels of progressive varying width, or of substantially uniform spacing. Smith, Jr. is directed to a heat exchange apparatus that employs "partitions" and "flow diverters" to create "labyrinthine flow channels" between inner and outer cylindrical shells of a rotatable drum drier. Smith, Jr. does not teach or suggest using baffles or partitions to separate the "branch supply passages" at either end of the rotatable drum drier.

Instead, the branch supply passages are "drilled or otherwise formed in drier head at uniformly spaced intervals" (Col. 5, lines 35-37). Fig. 5 shows eight outlet ends of branch passages (78 and 88) wherein the outlet ends are very small and considerably far apart from one another. Furthermore, the outlet ends are round, which does not suggest using baffles to create the passages.

Smith, Jr. utilizes branch passages similar to Richards' discrete radial passages. Since Smith, Jr. does not teach or suggest using baffles to create the branch passages, a person skilled in the art would not incorporate the "baffles" of Smith, Jr.'s labyrinthine flow channels between the inner and outer cylindrical shells with Richards' discrete radial passages. Furthermore, a combination of Smith, Jr.'s baffles with Richards' discrete radial passages would still result in discrete radial passages of uniform width (rather than progressive varying width) with rising distance between adjacent passages near the outer cylinder. Thus, Applicants request withdrawal of the rejection of Claims 4, 9 and 19 under 35 USC §103.

The rejection of Claims 5-7, 10-12 and 15-17 under 35 USC §103 as being unpatentable over the cited Richards patent is respectfully traversed. Claims 5-7 depend from amended Claim 1, which is patentable for the reasons presented above. Likewise, Claims 10-12 depend from Claim 2 which depends from amended Claim 1. Claims 15-17 depend from amended Claim 14, which Applicants believe is patentable for the reasons presented above.

Claims 5-7, 10-12 and 15-17 recite 10, 20 and 30 channels in the embodiments of the corresponding claims from which they depend. As set forth above, contrary to the Examiner's assertion, the Richards patent does not suggest important claimed features of the present invention regardless of the claimed number of channels. Furthermore, as explained on page 13 of the present specification, the number of channels is important because if there are too few in number, then angular flow of fluid within individual channels may occur to an undesirable degree. Richards does not suggest a specific number of channels, but shows 12 channels in each of the two groups. A comparison of the 24 channels in Richards to the Applicants' claimed number of channels is illogical because the two inventions are completely different. As explained above, Richards' channels are discrete, spaced apart tubes of uniform width separated into two groups, whereas Applicants' channels are divisions of a disk-shaped chamber. Applicants request withdrawal of this rejection.

The rejection of Claim 13 under 35 USC §103 as being unpatentable over the cited Richards patent in view of Eriksen et al. (U.S. Patent 5,846,232) is respectfully traversed. Claim 13 depends from amended Claim 1, which is patentable for the reasons presented above.

Eriksen et al. teaches a bent sheet with profiles in a helical pattern, such that fluid can flow through the ducts below the profiles and above the sheet through the annulus. The two-way flow mechanism in Eriksen et al. would not be a logical

combination with Richards to create the present invention, mainly because a combination of the teachings of Eriksen et al. with Richards would result in a two-way flow mechanism wherein the fluid flows through discrete, spaced apart tubes of mostly uniform width. In contrast, the present invention is geared toward a one-way flow mechanism, one embodiment of which utilizes a spiral flow pattern to help maximize heat transfer by facilitating an even and high degree of fluid fill, and high fluid velocity within the annulus, as explained on page 14 of the present specification. Applicants request withdrawal of this rejection.

Applicants believe that this case is now in condition for allowance. If the Examiner feels that any issues remain, then Applicants' undersigned attorney would like to discuss the case with the Examiner. The undersigned can be reached at (847) 490-1400.

Respectfully submitted,

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